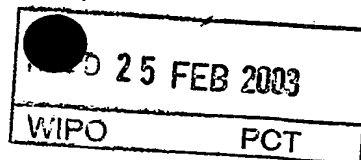
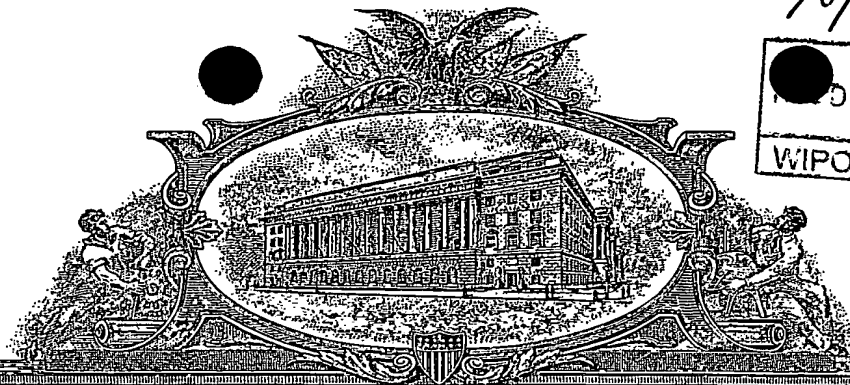


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APPLICATION NUMBER: 60/348,972

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PROVISIONAL APPLICATION UNDER 37 CFR 1.53 (b) (2)
TRANSMITTAL LETTER

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Transmitted herewith for filing is the Provisional Patent application of:

Gerd Hinzmann

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CANADA

Entitled: TOOL RIG FOR THE COMPACTION OF PARTICULATE MATERIAL

Enclosed are:

- 12 Pages of SPECIFICATION
- 7 Sheets of DRAWINGS (FIGURES 1-10)
- VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS
- Independent Inventor
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- X A CHECK in the amount of \$ 160.00 for the Provisional application Filing Fee is enclosed.

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Tool Rig for the Compaction of Particulate Material

Background of the Invention

Field of the Invention

The present invention relates to the art of forming products from particulate materials. More particularly, the present invention relates to the compaction of particulate materials. Still more particularly, the present invention relates to a new tool rig for the compaction of particulate materials.

Description of Related Art

In the manufacture of components or parts from particulate materials, a critical process is the compaction of the particulate material. Compaction is typically performed by filling a die cavity with the particulate material and applying pressure to the particulate material with a press.

The press has a driven main ram that moves in a single direction. The main ram is connected to a ram platen that moves with the main ram. In most cases, the main ram and ram platen move in a downward direction toward a base platen to perform the compaction. The main ram may be driven by hydraulic or mechanical means, as known to those skilled in the art. Depending on the operation, additional rams may be present to provide auxiliary motion in a vertical direction.

Press compaction may utilize different types of presses, among them a hybrid press and a hydraulic press. A hydraulic press includes a hydraulically driven

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main ram and hydraulic auxiliary motions. A hybrid press comprises a crank or knuckle driven main ram and hydraulic auxiliary motions. Adjustable mechanical stops are used to prevent auxiliary motion beyond the desired range.

A density as close to the theoretical density of the material is desired for a component made from a particulate material, because the mechanical properties of the component improve with increasing density of the compacted particulate. As a result, techniques have been developed to increase the density achieved through the compaction process. These techniques are often focused on multiple level parts, because the geometry of multiple level parts usually makes uniform density distribution between the levels more difficult. This discrepancy in density distribution adversely affects the performance of the part and may lead to the formation of cracks in the compaction process.

One technique to improve compaction of multiple level parts is that of a tool rig comprising a die that defines a cavity and at least one punch that extends into the cavity. The punch is typically actuated through auxiliary motion at some point during the compaction process to move the punch to a different vertical position and thereby increase the flow of the particulate material in the cavity to achieve higher and more uniform density distribution in the formed part. For parts with many levels, multiple punches may be used and each punch may be separately actuated.

In order to facilitate these actuated punches, designs of prior art tool rigs have relied upon cumbersome designs. A tool rig usually includes platens and/or cylinders to support each punch. Each of these support components must be independently movable to allow each punch to be independently actuated. Likewise,

each support component must have an independent source of energy to create independent motion of the support component and its respective punch. Such sources of energy may include connections to hydraulic or pneumatic media. Further, each support component typically has a linear encoder that measures the position and travel of the component, in turn measuring the position and travel of the punch that the component supports.

The independent supply requirements of encoders and energy sources for each component that supports an actuated punch have necessitated the design of vertically long tool rigs and presses in the prior art. The vertical length of a press dictated by designs of the prior art is illustrated in European Patent No. EP 0 586 028 B1, issued to present inventor and others, in PCT Publication No. WO 01/08864 A1, issued to Beane et al, and in European Patent No. 0 077 897/related U.S. Patent No. 4,482,307, issued to Schaidl et al. This excessive vertical length increases the height of the die travel and dictates a taller press, which leads to increased deflection of the press and consumption of valuable production space.

Accordingly, it is desirable to develop a new tool rig that allows encoders and an energy source to be connected to the tool rig components without a substantial increase in height, reducing the problems of deflection and occupation of excessive production space.

Summary of the Invention

The present invention provides a tool rig for the compaction of particulate materials such as powdered metals.

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In an exemplary embodiment of the present invention, a tool rig for the compaction of particulate materials includes an upper block disposed on a base. At least one cylinder is housed within the upper block. A core rod is disposed in the center of the tool rig and a central ring extends between the at least one cylinder and the core rod. The central ring defines a channel, whereby the central ring channel provides an energy supply to the cylinder.

In another exemplary embodiment of the present invention, a tool rig for the compaction of particulate materials includes an upper block disposed on a base. A first concentric cylinder is spaced from a second concentric cylinder and the first and second concentric cylinders are housed within the upper block. A central ring extends between the first and second cylinders and defines a channel, whereby the central ring channel provides an energy supply to at least one of the first and the second cylinders.

In yet another exemplary embodiment of the present invention, a tool rig for the compaction of particulate materials includes at least two concentric cylinders with at least two of the cylinders located at essentially the same elevation. A base plate located at an elevation different than that of the at least two cylinders supplies hydraulic power to a wall of each of the at least two cylinders. Linear encoders to measure the position of the at least two cylinders are included in the base plate. The base plate provides for a mechanical stop for at least one of the at least two concentric cylinders. The mechanical stop may be adjustable.

In still another exemplary embodiment of the present invention, a press includes a tool rig for the compaction of particulate materials.

Brief Description of the Drawings

The invention may take form in certain components and structures, exemplary embodiments of which will be illustrated in the accompanying drawings, wherein:

FIG. 1 is a front sectional view of a tool rig in accordance with an embodiment of the present invention;

FIG. 2 is a plan view of the base of the tool rig of FIG. 1;

FIG. 3 is a plan view of the tool rig of FIG. 1;

FIG. 4 is a front sectional view of a tool rig in accordance with another embodiment of the present invention;

FIG. 5 is a top sectional view of the base of the rig of FIG. 4;

FIG. 6 is a front sectional view of a tool rig in accordance with yet another embodiment of the present invention;

FIG. 7 is a plan view of the tool rig of FIG. 6;

FIG. 8 is a front sectional view of a tool rig in accordance with another embodiment of the present invention in a fill position;

FIG. 9 is a front sectional view of the tool rig of FIG. 8 in a compacting position; and

FIG. 10 is a front sectional view of the tool rig of FIG. 8 in an ejection position.

Detailed Description of the Preferred Embodiments

With reference to FIG. 1, a tool rig 66 designed to support three upper and three lower punches is shown. The tool rig includes an upper half 68 and a lower half 70. The upper half 68 is substantially a mirror image of the lower half 70, thus, reference herein will be made only to the lower half 70 but will be understood to include the upper half 68. The lower half 70 of the tool rig 66 includes an upper block 72 and a base 74. Housed within the upper block 72 are an outer concentric cylinder 76, a middle concentric cylinder 78 and an inner concentric cylinder 80. These cylinders 76, 78 and 80 provide support for the lower punches (not shown) and are movable along the vertical axis of the tool rig 66 in response to the supply of an energy source, such as hydraulic fluid. A central bore 82 for the core rod (not shown) is defined in the inner diameter of the inner cylinder 80. Disposed between the middle cylinder 78 and the inner cylinder 80 is a stationary central ring 84. The central ring 84 allows access to the middle cylinder 78 and the inner cylinder 80 for the supply of the energy source from between the cylinders 78, 80.

Housed within the base 74 of the lower half 70 of the tool rig 66 are linear encoders. A linear encoder 86 for the outer cylinder 76, a linear encoder 88 for the middle cylinder 78 and a linear encoder 90 for the inner cylinder 80 are all mounted within the base 74. The encoders 86, 88 and 90 extend from the base 74 into each respective cylinder 76, 78 and 80 and measure the compaction cycle travel of the cylinders 76, 78 and 80.

The base 74 also defines supply channels 92 and 94. These channels 92 and 94 facilitate the connection of the energy supply. The channels 92 and 94 continue

from the base 74 into the central ring 84 to provide the energy supply to the middle cylinder 78 and the inner cylinder 80.

With continuing reference to FIG. 1, a pocket 96 is defined between the inner cylinder 80, the central ring 84 and an inner seal ring 97. A pocket 98 is defined between the middle cylinder 78, the central ring 84 and a middle seal ring 99. The seal rings 97 and 99 are fixed to the central ring 84. Channel 92 supplies pocket 98 and channel 94 supplies pocket 96 with the energy supply, typically a compressible gas or hydraulic fluid. The inner cylinder 80 includes a radial projection 100 about its outer circumference that rides within the inner cylinder pocket 96. The energy supply is provided to a lower portion of the pocket 96 via the channel 94 to urge the projection 100, and hence the inner cylinder 80, upward. The projection 100 travels vertically within the inner cylinder pocket 96 as dictated by the energy supply. The travel distance of the inner cylinder 80 and the punch it supports corresponds to the distance the projection 100 travels in the pocket 96.

The middle cylinder includes a radial projection 102 about its inner circumference that rides within the middle cylinder pocket 98. As with the inner cylinder 80, the energy supply is provided to a lower portion of the pocket 98 via the channel 92 to urge the projection 102, and hence the middle cylinder 78, upward. The projection 102 travels vertically within the middle cylinder pocket 98 as dictated by the energy supply. The travel distance of the middle cylinder 78 and the punch it supports corresponds to the distance the projection 102 travels in the pocket 98.

The outer cylinder 76 also includes a radial projection 104 about its outer circumference that similarly rides within a pocket 106 defined between an outer wall of

the upper block 72, the outer cylinder 76 and an outer seal ring 108. The outer seal ring 108 is fixed to the upper block 72. The outer cylinder pocket 106 is connected to the energy supply through a channel (not shown) defined in the upper block 72, typically from the side of the upper block 72. As with the inner 80 and the middle 78 cylinders, the energy supply dictates the travel of the outer cylinder 76 and the punch it supports.

Turning now to FIG. 2, a top view of the base 74 of the lower half 70 of the tool rig 66 is illustrated. A port 110 for the linear encoder 86 of the outer cylinder 76 is defined in the base 74, as are ports 112 and 114, for the encoders 88 and 90 of the middle cylinder 78 and the inner cylinder 80, respectively. The energy supply channel 92 for the middle cylinder 78 includes an inlet 116 and an outlet 118. The energy supply channel 94 for the inner cylinder 80 also includes an inlet 120 and an outlet 122. From this view, the connecting rods 124 of the die platen can be seen passing into the base 74.

With reference to FIG. 3, a plan view of the lower half 70 of the tool rig 66 further illustrates the relationship between the cylinders 76, 78 and 80 and the inner seal ring 97, the middle seal ring 99 and the outer seal ring 108. Also shown are the connecting rods 124 of the die platen.

Turning now to FIG. 4, a tool rig 128 to support two punches is shown. The tool rig 128 includes an upper block 134 and a base 136. To support the punches (not shown), the tool rig 128 includes an outer cylinder 138 and an inner cylinder 140, each of which is movable along the vertical axis of the tool rig 128 in response to the supply of an energy source, such as hydraulic fluid. A stationary central ring 144 is disposed in the inner diameter of the inner cylinder 140. A central bore 146 for a core

rod (not shown), is defined in the central ring 144 and allows a central orifice to be formed in the part being compacted. The central ring 144 allows encoders and an energy supply to be connected to the inner cylinder 140 from its interior, eliminating the need for an inner cylinder that is longer than the outer cylinder 138. The base 136 houses a linear encoder 148 for the outer cylinder 138 and a linear encoder 150 for the inner cylinder 140.

Lower and upper channels 152 and 154 for the connection of an energy supply, such as hydraulic fluid, to the inner cylinder 140 are defined in the base 136 of the tool rig 128 and continue into the central ring 144. A pocket 156 is defined between the inner cylinder 140, the central ring 144 and an inner seal ring 157. The inner seal ring 157 is fixed to the central ring 144. The pocket 156 includes an upper portion 158 and a lower portion 160. The inner cylinder 140 includes a radial projection 162 about its inner circumference that rides within the pocket 156. The lower channel 152 supplies the hydraulic fluid to the lower portion 160 of the pocket 156 to urge the projection 162, and hence the inner cylinder 140, upward. In this manner, the travel of the punch supported by the inner cylinder 140 is controlled. The upper channel 154 may be a pressure relief channel, or it may supply the upper portion 158 of the pocket 156 with hydraulic fluid to urge the projection 162, and the inner cylinder, downward.

With continuing reference to FIG. 4, a pocket 164 is defined between the outer wall of the upper block 134, the outer cylinder 138 and an outer seal ring 165. The outer seal ring 165 is fixed to the upper block 134. A radial projection 166 extends about the outer circumference of the outer cylinder 138 and rides within the pocket 164. The hydraulic fluid is supplied to this pocket 164 through a channel (not shown) in the

upper block **134** to control the movement of the projection **166**, and thus the outer cylinder **138** and the punch that it supports.

An adjustable mechanical stop **172** may also be included in the tool rig **128** to allow the cylinders **138**, **140** to have an adjustable lower limit of movement.

FIG. 5 illustrates the base **136** of the tool rig **128** from a top view. The detail of the mechanical stop **172** can be seen, particularly the rod **174** that allows the stop **172** to be adjusted.

Turning now to FIG. 6, an alternative embodiment of the tool rig **128** to support two punches is shown. The tool rig **128** includes the upper block **134** and the base **136** of the prior example. The outer cylinder **138** and the inner cylinder **140** are present to support the punches (not shown). The central ring **144** is disposed in the inner diameter of the inner cylinder **140**. However, the lower and upper channels **152** and **154** for the connection of hydraulic fluid to the inner cylinder **140** are replaced by supply members **176** and **178**. In this embodiment, rather than pass through an inner portion of the central ring **144**, the supply members **176** and **178** extend directly through the base **136** to a lower portion of the inner cylinder **140**. Thus, the inner cylinder **140** may be urged upward by the hydraulic fluid from supply members **176** and **178**, and may be stopped by the adjustable mechanical stop **172** when the hydraulic pressure is released or overcome.

FIG. 7 further illustrates the relationship between the outer cylinder **138**, the inner cylinder **140**, the outer seal ring **165** and the inner seal ring **157** of the tool rig **128**. The connecting rods **180** of the die platen extend into the tool rig **128**.

With reference to FIG. 8, the two-cylinder tool rig **128** without the mechanical stop **172** is shown in a fill position. The tool rig **128** may include a die platen **182** that houses a die adapter **184**. The die adapter **184** receives a die **186** that defines a cavity **188**. The cavity **188** holds the particulate material or pre-form that is compacted by use of the tool rig **128**. On top of the inner cylinder **140** is an adapter **190**. The adapter **190** facilitates the support of an inner punch **192** by the inner cylinder **140**. Surrounding the inner cylinder **140** is the outer cylinder **138**. The outer cylinder **138** supports an adapter **194**, which in turn supports an outer punch **196**. This system of cylinders **138**, **140** and adapters **190**, **194** allows the outer punch **196** and the inner punch **192** extend into the cavity **188** when the tool rig **128** is in the fill position. A core rod **198** is disposed in the central ring **144** and also extends into the cavity **188**.

Turning now to FIG. 9, an upper punch **200** may enter the cavity **188** when the tool rig **128** is in a compaction position. FIG. 10 illustrates the tool rig **128** in an ejection position, wherein a compacted part **202** is pushed out of the die **186** by the punches **192**, **196**.

The use of the central ring reduces the excessive height required for a press that compacts parts made from particulate materials using multiple punches. This reduces the deflection of the press, thereby increasing the quality of the parts made and the life of the press. In addition, the press occupies less vertical production space.

The above examples have described in detail a tool rig a modular design to allow multiple rigs to be used on a single press. However, it is also anticipated that a press may be designed with the tool rig of the present invention as an integral component. A press that may utilize the tool rig either as a modular unit or as an

integral component includes a frame. The frame may provide main ram motion, actuation of the die and the core rod, and electric or hydraulic controls.

Particular note is made that at least two concentric cylinders of the tool rig of the present invention are at essentially the same level in a non-compacting position. Further, a base that is on a different level contains encoders and means to provide an energy supply to each concentric cylinder. The invention has been illustrated with respect to a tool rig that supports two or three punches. However, support of more punches may be accomplished using the design of the present invention.

The invention has been described with reference to the preferred embodiments. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of this disclosure.

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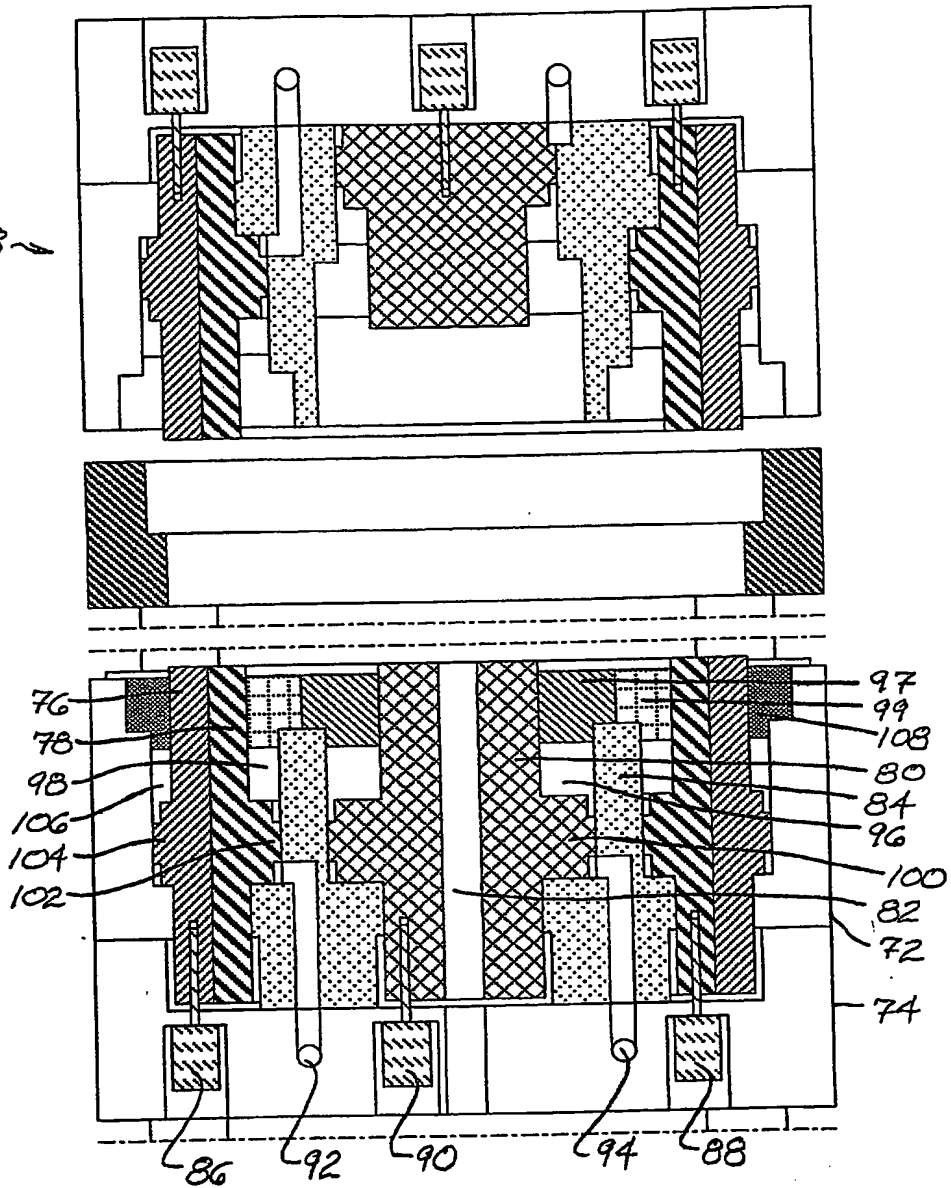


FIG. 1

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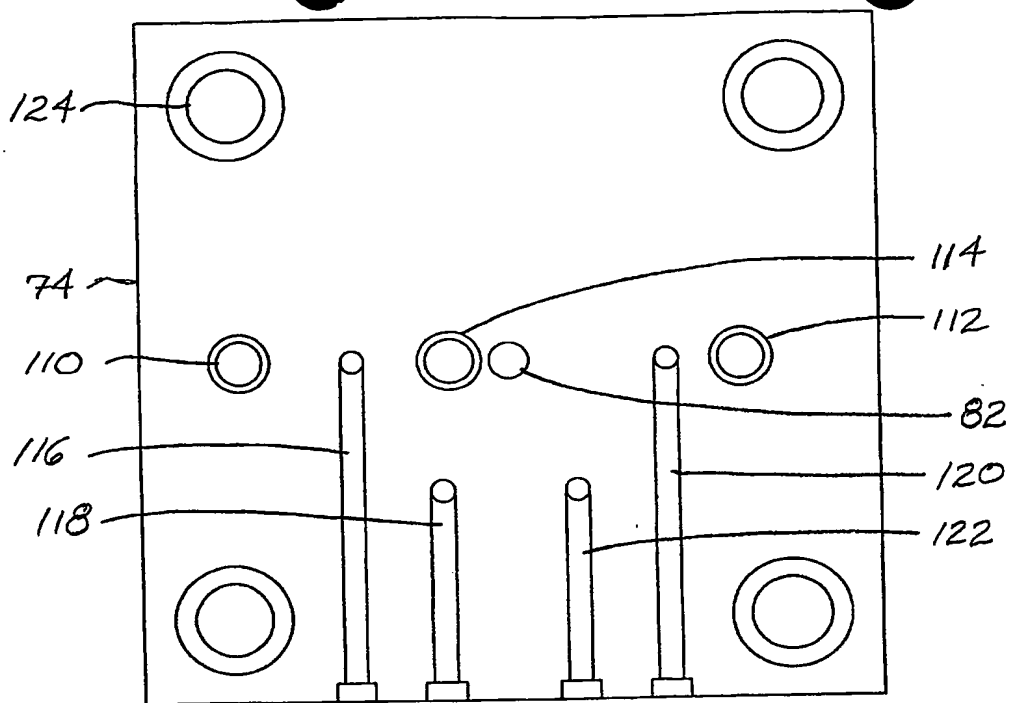


FIG. 2

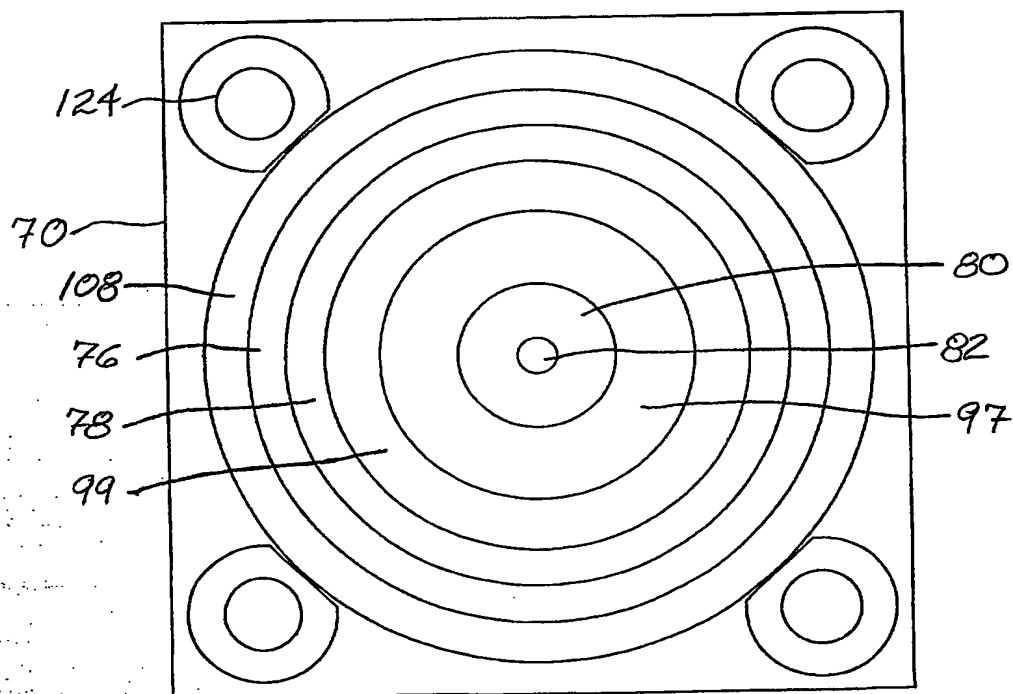


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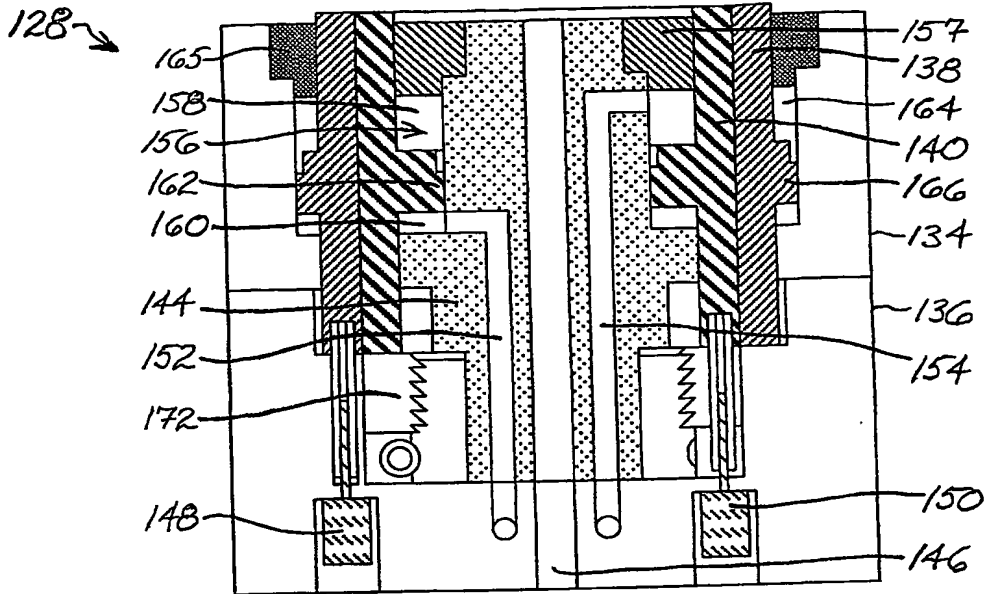


FIG. 4

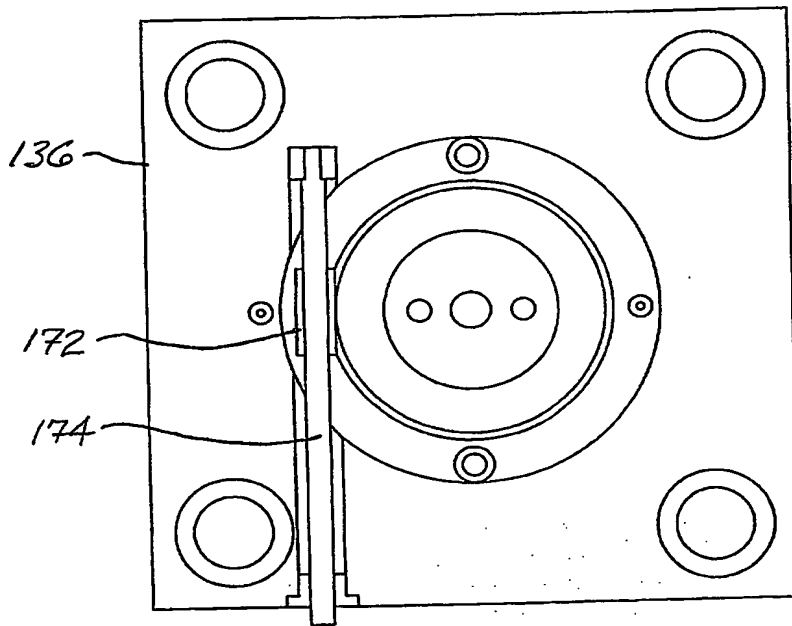


FIG. 5

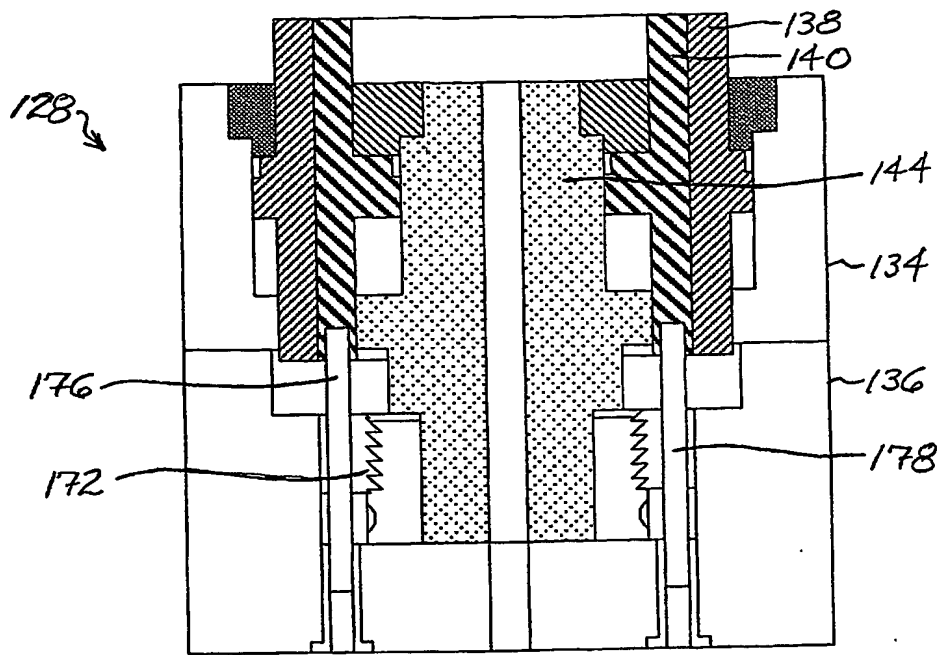


FIG. 6

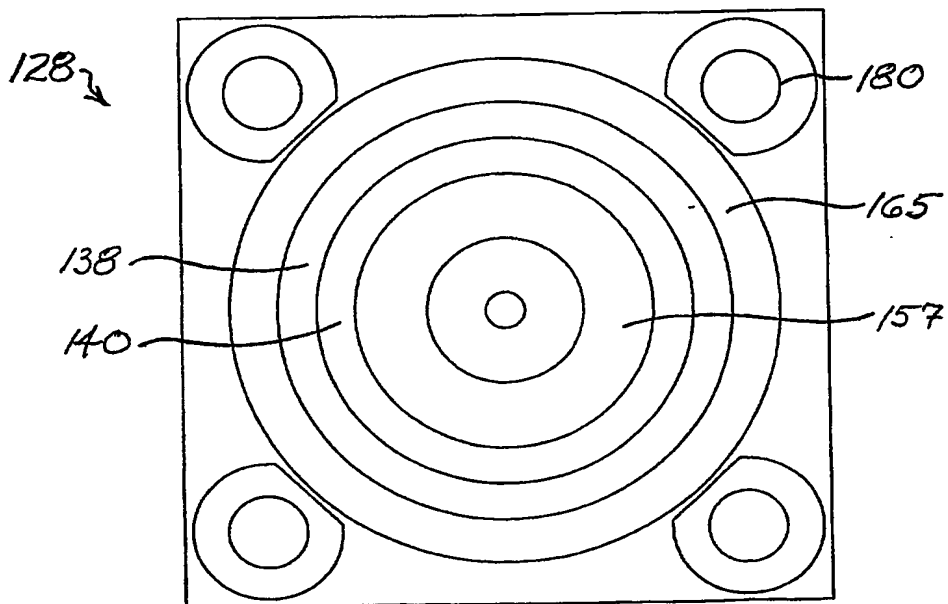


FIG. 7

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128 →

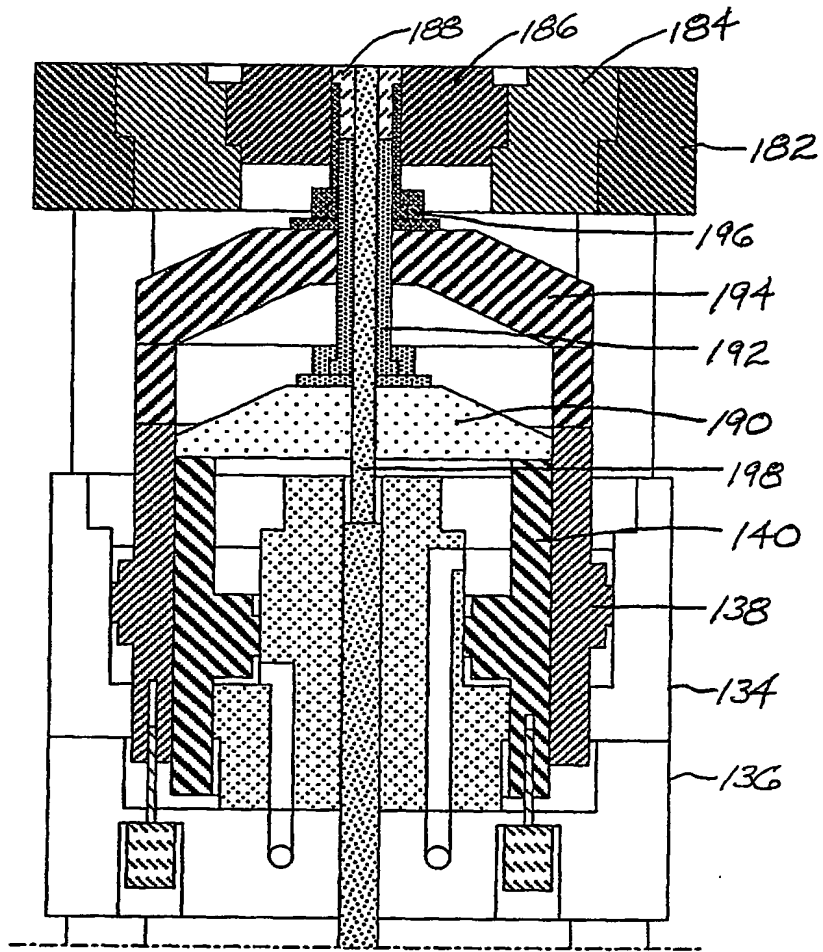


FIG. 8

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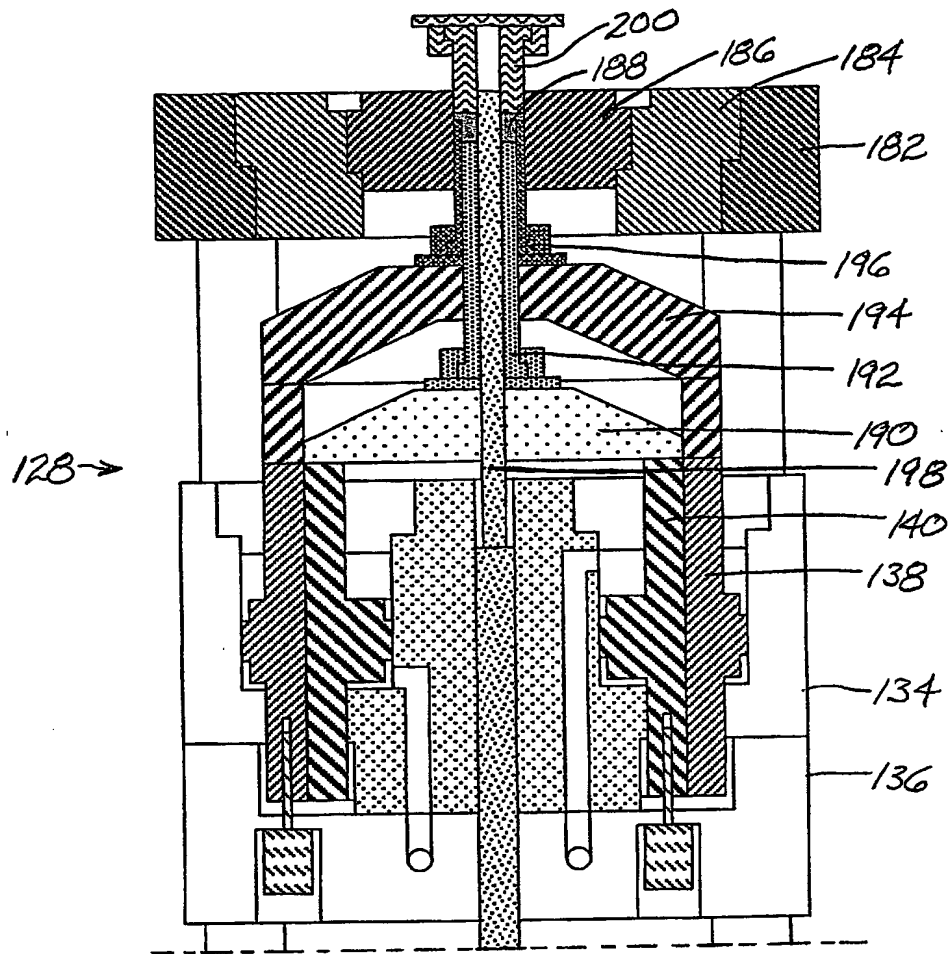


FIG. 9

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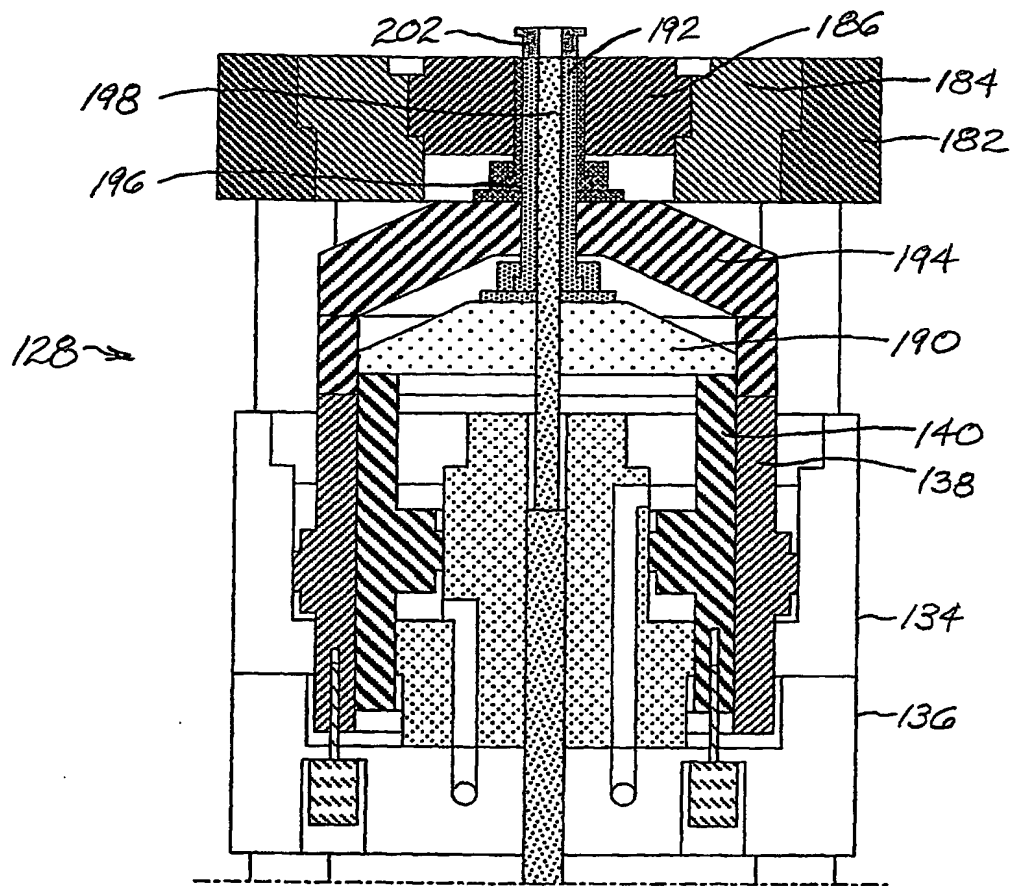


FIG. 10

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